I – Problem Statement Title (EQ 019)

Develop Guidelines for Post-Event Bridge Damage Mitigation

II – Research Problem Statement

Question: How can we quickly and accurately inspect a bridge after an extreme event and determine cost-effective short-term traffic restoration measures and long-term repair strategies?

Develop methods, tools and guidelines for quick and accurate inspection of bridges immediately after an earthquake. Develop methods, tools and guidelines for short-term restoration of traffic function and for long-term repair and upgrade of the bridge.

Conduct a best-practice survey, collect data from Caltrans databases, and develop guidelines for

III – Objective

STAP Roadmap Outcome: 8. Improved Performance of Bridges and Highway Structures to Earthquakes and other Main-Made and Natural Extreme Events, and Improved Ability to Quickly Restore Facilities to Full Functionality; Problem #4: Facility Restoration

STAP Roadmap Outcome: 2. Extended Service Life of Existing Bridges and Highway Structures; Problem #2: Extreme Events

The objective of this research is to develop methods, tools and guidelines for highway bridge damage mitigation after an extreme event. The first part of these guidelines focuses on methods and tools for inspection of highway bridges after an earthquake. The material in these guidelines will be derived from a best-practices survey and inspection data collected from Caltrans databases, as well as from Caltrans experience on the behavior of instrumented bridges. The second part of these guidelines will be derived from best-practices survey of repair methods and Caltrans experience in past earthquakes, as well as from structural modeling and post-event (after-shock) response analysis of typical highway bridges repaired using the typical repair methods identified in the survey.

IV – Background

Nearly eighty percent of California highway bridges are cast-in-place post-tensioned concrete bridges. A large body of knowledge exists on the potential damage, effective inspection methods, as well as fast short-term traffic restoration and lengthy long-term repair techniques. However, the knowledge existing within Caltrans and within the design community outside Caltrans is based on the experiences form 1989 Loma Prieta and 1994 Northridge earthquakes. There is a danger that much of the

knowledge and experience will be lost simply because of engineering staff turnover and retirement. A survey of best practices and a collection of findings in an easy-to-search database organized by typical bridge types and sub-types is the best way to preserve such specialized and perishable knowledge. Furthermore, the database of repair methods can be backed up by structural calculations for typical bridges to give engineers guidelines for choosing repair and restoration methods, particularly when a short-term, but quick solution is needed to restore traffic. Another benefit from the proposed guidelines is an estimate of costs and time to conduct inspections, traffic restoration and repairs for a particular type of bridge and class of damage, that may be used to guide decisions on routing and repair prioritization in a regional traffic network.

V – Statement of Urgency, Benefits, and Expected Return on Investment

The amount of funds spent on rapid traffic restoration and long-term repair of bridges after an extreme event dwarfs the proposed budget to develop guidelines to improve post-event bridge inspection and optimize selection of traffic restoration and bridge repair methods. The urgency of conducting a best-practice survey is further underscored that the knowledge, accumulated 15 years ago during the last large earthquake event in California, is quickly evaporating with Caltrans staff turnover and retirement. Capturing such knowledge is priceless.

VI – Related Research

A similar research has been conducted by the PEER and MAE Earthquake Research Centers. This was a limited best-practice survey on repair duration for a particular type of bridge damage.

VII – Deployment Potential

The guidelines resulting form this research may be immediately deployed Caltrans-wide. Given they will be a result of a best-practice survey of Caltrans engineers, they should immediate traction, and, therefore, immediately contribute to lowering the cost of bridge inspection and repair while increasing bridge safety and overall traffic network reliability.